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Title of Invention: Method for producing reducing gas for blowing into blast furnaces

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Simple Explanation of Drawings:

Fig. 1 shows a vertical cross section of the gasification furnace of an apparatus for producing reducing gas in a working example of this invention. Figs. 2 and 3 are the same kind of drawings as Fig. 1, showing modifications.

Detailed Explanation of Invention:

This invention concerns a device for producing reducing gas in cases in which blast furnaces are operated by blowing reducing gases into them, especially by blowing reducing gases obtained by partially oxidizing liquid fuels into them.

Methods of operating blast furnaces by blowing reducing gas into them are already publicly known, and various proposals for them have been made. When hydrocarbons, e.g., natural gas, which are in the gas phase at normal temperatures, are used as raw materials for such reducing gases blown into blast furnaces, the production of fine carbon particles during partial oxidation of the natural gas, etc., is hardly seen at all, whereas when hydrocarbons which are in a heavy liquid phase at ordinary temperatures are used as raw materials, one cannot avoid a slight production of fine carbon particles. Furthermore, in some blast furnace operation methods, such as that shown in (Japan) Patent Bulletin No. 315136, it has in fact been considered preferable for a certain quantity of fine carbon particles to be present in the gas.

However, as a result of various studies, the inventors discovered that almost all of the fine carbon particles produced during gasification are exhausted with the furnace top gas without being activated even in the blast furnace, and the presence of fine carbon particles is not desirable in operating blast furnaces.

Based on this discovery, this invention makes it possible to operate blast furnaces by blowing into their shaft parts a reducing gas from which the fine carbon particles produced during partial oxidation of hydrocarbons which are in a heavy liquid phase at ordinary temperatures are completely removed the fine carbon particles in the gas produced are removed by placing a solid carbonaceous material filtering layer below the gasification chamber of the gasification furnace which partially oxidizes the aforementioned liquid hydrocarbons, that is, in the lowest part of the aforementioned gasification furnace which has little direct effect on the gasification chamber reaction, or connecting a separate chamber to the aforementioned gasification furnace and placing this filtering layer in its lower part, and by adsorbing the fine carbon particles in the aforementioned filtration layer.

As the aforementioned solid carbonaceous material, one which has a certain strength when hot and does not become a fine powder or produce smoke is required; for example, a material such as coke or a graphite electrode with little ash content is desirable. The size of the carbonaceous material should be such that a filtering space is present and it is not carried by the gas passing through it. Moreover, ceramic materials of other shapes, especially tetrapod ceramic materials, may be mixed in with this carbonaceous material, especially when the strength of this material becomes a problem.

The details of this invention will be explained below according to the

drawings, in which the same parts are shown with the same symbols. With reference to Fig. 1, the gasification furnace is composed of a gasification chamber 1 and a filtration tank 2, placed below this gasification chamber 1. After the air in the gasification chamber 1 is replaced by nitrogen, which has been introduced from the deactivating gas introduction openings 3, the raw material and oxygen are sprayed into the gasification chamber from the raw material/oxygen introduction opening 4; they are ignited and the gasification is performed. In the initial period of operation of the gasification furnace, the temperature of the reaction zone of the gasification chamber 1 is low; therefore, the gas produced is released into the air through a suitable dispersion pipe (not shown in the drawing). When the temperature of the reaction zone rises and the components of the gas produced become the desired constant ones, it is passed through the filtration tank 2 and introduced into the shaft part of the blast furnace. The gasification chamber 1 is formed by refractory bricks 5, and its lower part is connected to the filtration tank 2 below it by a pathway 6.

A solid carbonaceous filter layer 8, consisting of solid carbonaceous material piled up in a layer, is formed on a refractory brick fire grating 7 in the filtration tank 2. In this working example, coke is used as the solid carbonaceous material.

As the reducing gas containing fine carbon particles produced in the gasification chamber 1 passes through the filter layer 8, the fine carbon particles are adsorbed and removed. Moreover, the CO_2 and H_2O produced in the gasification chamber 1 are reduced or decomposed while it passes through the carbonaceous filter layer and the

eg w. reaction Hydrogen atoms

by reaction against CO_2 or H_2O? Yes!

carbonaceous and other solid particles carried by the gas are removed by a trap 9 which is placed in the outlet of the filtration tank 8. The purified gas which has passed through the trap 9 is blown into the shaft part of the blast furnace from the outlet 10.

An oxygen zone is present at the top of the gasification furnace, but the free oxygen is prevented from contacting the carbonaceous filtration layer 8 and the carbonaceous material is prevented from being oxidized and consumed, by the separation of the gasification chamber 1 and the filtration tank 2. If a single chamber is formed, without separating the gasification chamber 1 and the filtration tank 2, the free oxygen is kept from contacting the filtration tank 2 by lengthening the gasification furnace, as in the conventional furnaces and as shown in Figs. 2 and 3. The furnace shown in Fig. 3 is constructed in such a way that a cyclone 11 is connected to the outlet 10 and the fine particles which are not removed by the filtration tank 2 are recovered by it. This cyclone 11 may also be added to the furnaces shown in Figs. 1 and 2, of course.

During the operation of the gasification furnace, it is desirable for heavy oil to be used as the raw material and exposed to and burned by pure oxygen, since almost no nitrogen is produced as an impurity and there is little production of fine carbon particles. Furthermore, it is desirable for the quantity of oxygen supplied to be such that almost no free oxygen is left, since there is no oxidation and consumption of the solid carbonaceous filtration layer 8 and the purity of the reducing gas is increased. If pure oxygen is used, as mentioned above, the gas produced reaches a temperature in the range of 1300–1500°C and the solid

carbonaceous filtration layer 8 is heated to this temperature range, the CO_2 reduction and aqueous gas reactions will proceed fully and the concentration gas concentration in the product gas will rise. Furthermore, these chemical reactions are endothermic, but since the high-temperature gas is continuously fed in, there is no chance that the gas temperature will be markedly lowered after it passes through the filtration layer. Since the filtration layer 8 is gradually consumed as the aforementioned chemical reactions proceed, the solid carbonaceous material is gradually supplemented from the upper part of the filtration tank 2 and the material which has become small particles is removed from the bottom. This operation may be performed during the operation of the gasification furnace, but it is desirable to provide 2 furnaces in series and use them alternately.

Furthermore, at the beginning of the operation, it is necessary to replace the air in the gasification chamber 1 and the filtration tank 2 beforehand by an inert gas to prevent waste consumption by combustion in the filtration layer 8, and the same treatment is required when the operation of the furnace is suspended.

Working Examples

As the raw material, a heavy oil (C: 8.55%, H_2: 13.5%, S: 1.0%) was blown into a furnace arranged as shown in Fig. 1 and passed through the filtration layer. In addition, a cyclone was used. It was possible to obtain a highly pure reducing gas with the composition and temperature shown below. As the filtration layer, a mixture of equal quantities of an especially

high-strength iron-making coke and pulverized graphite electrode (30–50 mm diameter) was used.

CO	5.10	(unit %)
CO_2	0.4	
H_2	44.0	
H_2O	3.0	
N_2	1.4	
Free C		Trace
Temperature		1350°C

As explained above, by means of this invention, almost all of the fine carbon particles produced in the gasification furnace are removed, the CO_2 produced by the partial oxidation, is reduced to CO in the filtration tank, and the water vapor is decomposed to hydrogen and CO. In this way, the purity of the reducing gas blown into the shaft part of the blast furnace is improved, and the blast furnace can be operated with a high efficiency. Furthermore, the highly pure reducing gas obtained by this invention is fully usable in metallurgical and chemical synthesis furnaces, besides blast furnaces.

Claims

1 A device for producing a reducing gas for blowing into blast furnaces, characterized in that, in a device for obtaining a reducing gas by partially oxidizing liquid hydrocarbons at ordinary temperatures by means of oxygen or air, a solid carbonaceous filtration layer is placed in the lowermost part of the gasification furnace, which receives little effect from

the gasification chamber reaction, as a place in which the free oxygen in the gasification chamber is not directly contacted.

Literature Cited:

(Japan) Patent Bulletin No. 35-5611

(Japan) Utility Model Bulletin No. 14-3408

Seitetsu, Seikou Kinzoku Kougaku Kouza 4 *Seiren Hen* II (*Lectures on Iron- and Steel-Making Metallurgy* 4: *Refining*, Part II) (Feb.20, 1961), pp. 192–193, publ. Asakura Shoten

Fig. 1

第1図

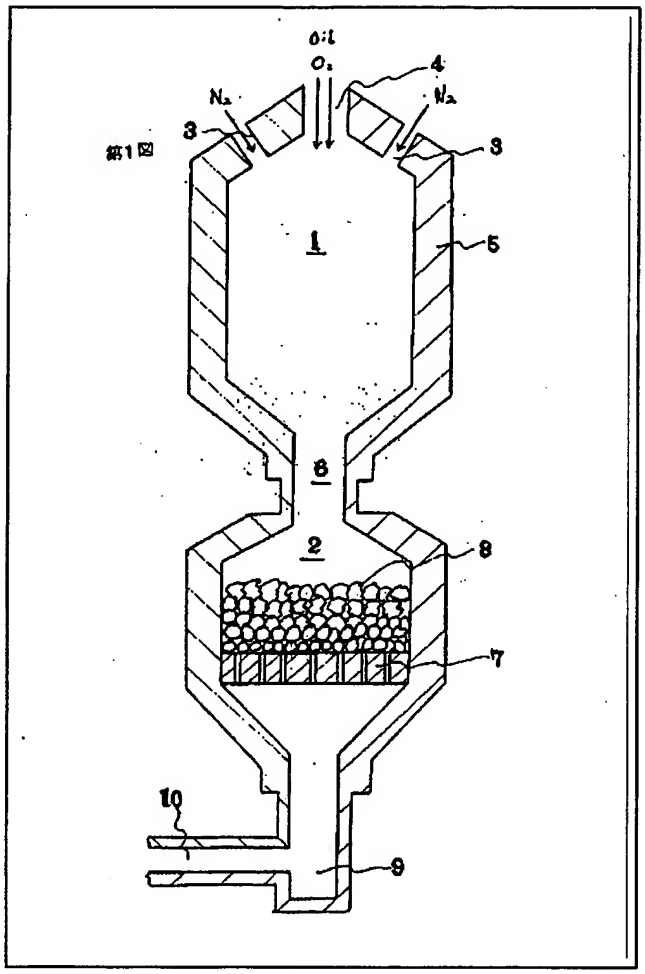

Fig. 2

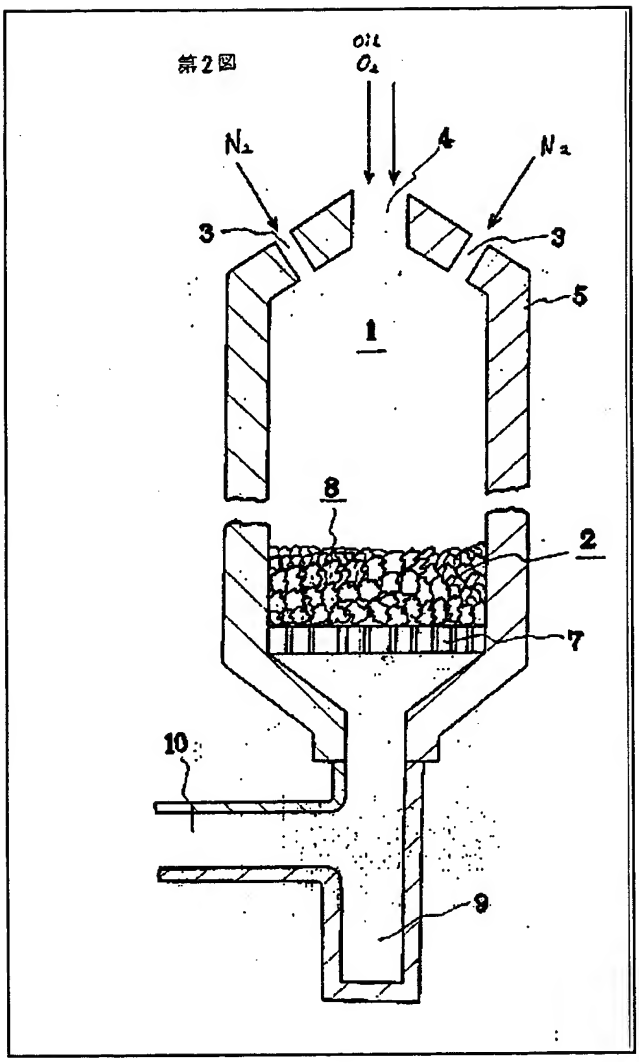

Fig. 3